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ABSTRACT

This paper describes the development of an interoperable meta-database system--a system of applications using metadata--that is intended to facilitate learner-centered collaboration, access to learning resources, and the fitness of channels of information to the emerging needs of learners at both individual and group levels. Highlights include: self assembly approaches in artificial intelligence; definition of several relevant concepts, e.g., elements/paths, fitness functions, recombination, and feed forward/feedback paths; and types of metadata, e.g., audience, discipline, and theme. The new World Wide Web-based educational database applications are preparing to use the concepts of self-assembly to treat digital media paths as a new form of texts and courses in education. (Contains 14 references.) (Author/MES)

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Self- Assembling Texts & Courses of Study

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Abstract: This paper describes the development of an interoperable meta-database system - a system of applications using metadata - that is intended to facilitate learner-centered collaboration, access to learning resources, and the fitness of channels of information to the emerging needs of learners at both individual and group levels. The new web-based educational database applications are preparing to use the concepts of self-assembly to treat digital media paths as a new form of "texts and courses" in education.

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Introduction

New media = new modes of thinking. New tools for thinking and expressing have a profound effect on learning. They don't just change how we access information. New tools change the very modalities, scope and depth of how we see and interact with the world. For example, because MTV music videos led to television and print ad commercials with documentary-like, visual flashes of information; textual narratives of the past have given way to film-like story lines. Because online "chat rooms" led to new forms of "talking" with several people at once and asynchronous "listservs" and "threaded discussions" led to group archives, the concept of classroom dialog is evolving. Being able to see the 3-dimensional structure of a storm leads to new insights into the complex dynamics involved. And math classes with computer simulations and modeling are a different breed than math classes with only a pencil or chalkboard for representation. These are examples of how new media changes thinking as well as ways of working.

Learning through texts and courses is evolving to take advantage of new media and the globally connected web of experts, knowledge and tools. "Texts" now mean rich digital media streams; "courses" mean episodes and series of engagements spread across space and time. In both texts and courses, the static pre-planned paths and chapters of the past are giving way to more flexible ways of putting materials together for learning. This paper begins to discuss the application of the concept of self-assembly in a new web-based educational database application that treats digital media paths as a new form of "texts and courses" in education.

Self-Assembly

The word phrase "self-assembly" refers to something that is capable of putting itself together. The phrase also brings up images of self-organization, pulling oneself up by the bootstraps, spontaneous generation, and evolution - "something" coming from "nothing." How do these processes work and what might they mean for educational texts and curriculum?

Processes of self-organization are prevalent in both materials sciences and artificial intelligence research today. In materials science, self-assembly most often refers to the three-dimensional conformation of materials brought about by catalytic agents or processes; for example, through evaporation and vibration. (AMP, 1998 & 2000; Discover, 1998; Ingber, 1998) Engineers who previously thought in Cartesian, gears-and-straight-line terms are finding the mixture of biology and hardware and software to be liberating. (Petit, 1998)

In artificial intelligence (AI) research, self-assembly approaches include using "neural networks," "genetic algorithms" and "genetic programming" as the catalytic agents and processes (Engel, 2000; Sette,

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Boullart & Van Langenhove, 1997). In the world of information and AI, as the conformational role expands to mean interacting-bodies of information, the complexity expands to n-dimensions, in configurations sometimes referred to as "landscapes" where "fitness" processes occur. The brain science and evolutionary metaphors in AI begin to give us clues as to why we might want to pay attention to self-assembly of texts and courses. The AI approaches have been characterized as:

- convenient for the implementation of model-based control strategies (Kulkarni, Tambe & Dahule, 1999)
- producing good results when a search field is too large to use conventional search or optimization techniques, and possessing an ability to undertake searches with few presumptions about the outcome (von Rönik, 1997)
- Useful when the complexity of a process is very high and no mathematical function is known to exist that represents the whole process; and where there are multiple objectives for optimization (Sette, Boullart & Van Langenhove, 1997)

We explore here two extensions of these kind of core ideas for a web-based set of educational applications. We envision "texts" (meaning any digital multimedia format used in teaching – digital video, audio, texts, pictures, tactile computer interfaces such as steering wheels, ramps and pulleys) and "courses of study" (meaning a planned and coordinated sequence of learning episodes) that can put themselves together. Some concepts helpful for the discussion:

- **Elements and Paths** – multimedia granules or chunks of information connected in a web of relationships through one or more "story lines." Elements can be singular or organized into complexes via subpaths. A path refers to a longer line of thinking/representation that organizes several elements or complexes. An element is a thing; a path is a relationship.

- **Fitness functions** – defined in part by the strengths, interests and aspirations of a learner, and in part by the professional and organizational goals in the learner's contexts. Fitness occurs when the learner's profile meets the structure of information and an exchange of resources occurs that is mutually beneficial to the learner and the world of knowledge.

- **Recombination** – mixing up elements of information and presenting new cross-fertilized ways of seeing and thinking about those chunks.

- **Feed Forward & Feedback Paths and Loops** – linear and nonlinear connections among the elements, which can have positive and negative influence on other element complexes as they form internal and external relationships.

A metaphor for the connections is a "loop," "trail" or "path" model of cross-referenced materials. For example, let's use three separate four-element paths to illustrate (Figure 1). In the first path, four multimedia elements (text, sound, video, jpg, etc) are associated with a theme such as "teaching civil rights in a high school history class." One of the elements is a video clip of "Martin Luther King" and is also found on a second path having to do with speeches of political leaders in the early 20th century after World War II. That path intersects with a third path that contains other post-war elements of culture and society.

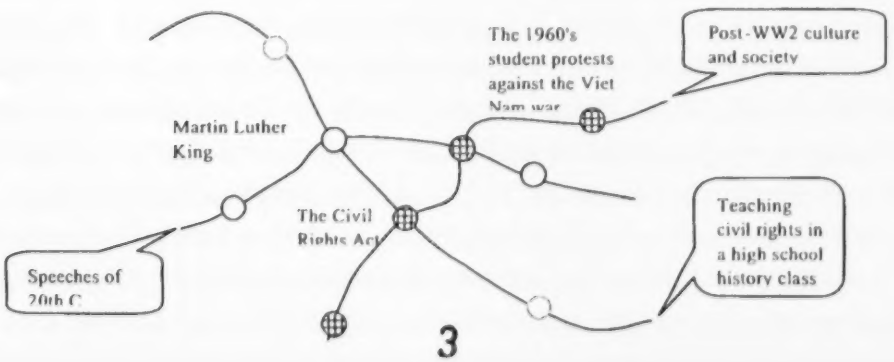
The 1960's student protests against the Viet Nam war
Post-WW2 culture and society
Martin Luther King
The Civil Rights Act
Teaching civil rights in a high school history class
Speeches of 20th C

Figure 1. A path model of cross-referenced materials

The media chunks represented by element points in the web of relationships are small self-contained, self-running, self-explanatory chunks of digital information with metadata that assists in the formation of the paths. Possibilities for the metadata include

- "Audience" with qualifiers for age, grade level or level of expertise
- "Discipline" making an association with the media chunk for application within a specific field of knowledge. (e.g. the "I Have a Dream" speech as part of fields such as Political Science, Television & Media, or African American Studies)
- "Theme or Big Idea" taking the expert consensus on the major ideas of the related discipline and relating those to the elements (e.g. the King speech as Oratory, Documentary, Facing Historical Oppression).
- "Teaching points" with subject-object-predicate structures such as "galvanized public opinion about rights," "influenced the media and arts," or "led to campus riots." The teaching points might be story summaries among many that are subsets of the discipline using that element.
- "Story Line" a framework for basic narrative flow, e.g. beginning, middle, end, flashback series, historical, working backwards from high point, theme and variations, metaphoric comparisons, struggle of opposites, montage, etc.
- "Position" information in terms of outline or story line hierarchy such as "overview," "descriptive detail," "justification," "opposing view to x," etc.
- "Order or precedence" using historical, logical, causal, etc.

The paths connecting elements are multicausal (complex nonlinear) relationships with bidirectional capabilities. One element can have a positive influence on the next element or group of elements at one point in time, and have a negative influence at another point in time. As well, within each element there can be a complex crossing of directionality (e.g. playing different influence roles in two different paths at the same time). The agent will have to maintain simultaneous contradictory channels in an evolving configuration of relationships. "Meaning" within the channels will come at least partially from a model of the path as a whole, and in some instances, from "crosstalk" or superposition of wave functions within the element or a subpath itself.

The weights in the valuation structure of the model of the learner will play a role in defining the paths and determining the distances between elements on different paths. The natural language-like structures of the metadata will constitute a fuzzy model of the world that has two perspectives: the "model of the learner" perspective and the "model of the field of knowledge" (the combined weighted paths of the participating experts' models of the field of knowledge). When these two perspectives meet each other, there is a kind of tug of war between the learner's interests and ideas with those of the field, leading to the idea of "fitness" of the two perspectives or landscapes for each other. (see Csikszentmihalyi, 1996)

Fitness functions in the context of texts and courses will refer to the evolving configurations of strengths, interests and aspirations of a learner, as well as the professional and organizational goals in the learner's contexts. Both direct and implied collection & analysis methods will create the functions. For example, a direct collection method might be a survey of the learner, a personal profile, a test, or an interview. Implied collection methods might include tracking a learner's searches, uses of resources, and public communications with experts and others.

The self-assembling text will need to be able to build a model of the learner and adjusts its model over time to fit the changing configurations of the learner. In short, it needs to involve an adaptive agent that represents the learner in the web space and interact with other adaptive agents representing the knowledge structures in the web space. Valuation functions with weighted sums, as used in Arthur Samuel's checkers game player (1959) may provide the kind of thinking needed to construct the agents.

With the idea of recombination, we get both abundance and new connections. Abundance is needed to generate alternatives and new connections are needed to store memories of the past and to measure the distance of those to future connections.

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Self- Assembling Texts

We are using the word "text" to mean a rich digital media stream utilizing all forms of storytelling, film and video, reading, audio, visualization and so forth.

Several scaffolds, narratives, streams of thought, outlines and story line formats at various "sizes and shapes" (determined for example by time to display and read/view, number of elements, and message complexity) will provide seed structures for the self assembly of texts. Time scales might range from 5 to 15 minute episodes to several hours, as in a miniseries, that would take several days to experience, but that could be approached in convenient samples of time. The number of elements might range from 3 or 4 (each of which may involve several media subelements and last from 30 seconds to 2 or 3 minutes) to several hundred or thousand per story line. Message complexity may have both intensive and extensive dimensions. Intensively, the level of complexity refers to the detail, depth of coverage and the vertically integrative scope of the topic within one or more representation hierarchies (as in part to whole relationships). Extensively, the level of complexity refers to the "same level" or peer-to-peer scope of relationships involved in the story line (as in whole to whole relationships). The complexity levels may be defined in terms of the numbers of elements, connectors, loops, and intersections both internally and externally that constitute a particular weighted path for the current purposes of a story line.

The seed structure of the self-assembling text implies that we need to create a new form of metadata that sits at a higher level of abstraction utilizing lower level metatagged media elements as pieces. For example, given a topic such as "stream biology" there may be many "introductory" sequences, which are differentiated to suit "body messages" of "macroinvertebrates", "energy production", or "city and recreational planning."

Production of the metadata structure of the story lines can at first come from existing texts, films and other media productions, but the ideal system will then evolve with new paths being added by knowledge-producing learners and experts.

Self- Assembling Courses of Study

The old structure of schooling was dominated by courses of study that had been created by a single teacher. The courses were designed to move a group of learners from some level of knowledge and ability to another, coordinated primarily through common texts, exercises and tests held at common meeting times.

The new structure of learning made possible by "anytime, anywhere" telecommunication networks and new media allows a natural emergence of a course of study. The course of study arises out of the interactions and dialog among a learner's expressions of interest, strengths and aspirations, a peer and expert community that shares interests as well as guides the learner, and the wider world of expertise systems.

As new courses develop, old educational functions take on new meaning. For example, "registration" will be accomplished through searches, self-assessment, and asking questions. "Forming goals" for the course will occur within a dialog with scaffolded self-guidance and with advisors and other learners. "Monitoring progress" will occur through learner and advisor talks, draft works and the feedback process, and ongoing assessment. "Completion and validation" of course and program attainment will follow how a work becomes evidence. Paths and subpaths will link up into book-length units. Role of human mediation w/agents and texts will become an integrated support system for the learner.

In the Personal Learning Planner (PLP), recently created by the National Institute for Community Innovations, a number of online structures are moving into place to take advantage of the self-assembly of texts and courses. Performances are moved outside of classrooms and focused on evidence of a small number of important standards. Common stable scoring guides with examples of work are provided across a boundary-free professional landscape. Managing multiple non-linear pathways of choice by learners and advisor groups and individuals is supported.

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